NEW SEWARD HIGHWAY AND TUDOR ROAD INTERCHANGE

Project No.: CE201907

DESIGN STUDY REPORT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC FACILITIES

PREPARED BY: HIT Engineers, Inc.
2900 Spirit Way
Anchorage, AK 99508

April 22, 2019

STATE OF ALASKA

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
DESIGN AND ENGINEERING SERVICES – CENTRAL REGION

DESIGN STUDY REPORT

For

New Seward Highway and Tudor Road Interchange

Project No.: CE201907

Written by: Mar Angelo E. Fernandez

Prepared by:

____

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Concur by:

____

R. Vince Flack Date
Project Manager - HIT Engineers, Inc.

Concur by:

____

Christopher L. Post, P.E. Date
Project Manager - DOT&PF

Approved:

____

Kristina Busch, P.E. Date
Engineer I - DOT&PF

NOTICE TO USERS

This report reflects the thinking and design decisions at the time of publication. Changes frequently occur during the evolution of the design process, so persons who may rely on information contained in this document should check with the Alaska Department of Transportation and Public Facilities for the most current design. Contact the Project Manager, Christopher L. Post, at (907) 269-0585 or at chris.post@alaska.gov for this information.

PLANNING CONSISTENCY

This document has been prepared by the Department of Transportation and Public Facilities according to currently acceptable design standards and Federal regulations, and with the input offered by the local government and public. The Department's Planning Section has reviewed and approved this report as being consistent with present community planning.

CERTIFICATION

We hereby certify that this document was prepared in accordance with Section 520.4.2 of the current edition of the Department's Highway Preconstruction Manual.

The Department has considered the project's social and economic effects upon the community, its impacts on the environment and its consistency with planning goals and objectives as approved by the local community. All records are on file with Central Region - Design and Engineering Services Division, Highway Design Section, 4111 Aviation Avenue, Anchorage, AK 99502.

Christopher L. Post, P.E.	Date	Kristina Busch	Date
Project Manager - Highway Design		Engineer I - Highway Design	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS

AASHTO -	American Association of State Highway and Transportation Officials
CGP -	Alaska Construction General Permit
ADA -	Americans with Disabilities Act
ADEC -	Alaska Department of Environmental Conservation
APDES -	Alaska Pollutant Discharge Elimination System
ARRC -	Alaska Railroad Corporation
ATM -	Alaska Traffic Manual
BMP -	Best Management Practice
CFR -	Code of Federal Regulations
DOT&PF -	Alaska Department of Transportation and Public Facilities
ESCP -	Erosion and Sediment Control Plan
EPA -	Environmental Protection Agency
FHWA -	Federal Highway Administration
HPCM -	Alaska Highway Preconstruction Manual
HMCP -	Hazardous Material Control Plan
HSIP -	Highway Safety Improvement Program
LOS -	Level of Service
MADT -	Monthly Average Daily Traffic
MOA -	Municipality of Anchorage
MP -	Milepost
MPH -	Miles per Hour
MUTCD -	Manual on Uniform Traffic Control Devices
NPDES -	National Pollutant Discharge Elimination System
PGDHS	A - Policy on Geometric Design of Highways and Streets
PIP -	Public Information Plan
ROW -	Right-of-Way
SWMM -	Storm Water Management Model
SWPPP -	Storm Water Pollution Prevention Plan
TCP -	Traffic Control Plan
TDI -	Tight Diamond Interchange
TMP -	Traffic Management Plan
USGS -	United States Geological Survey

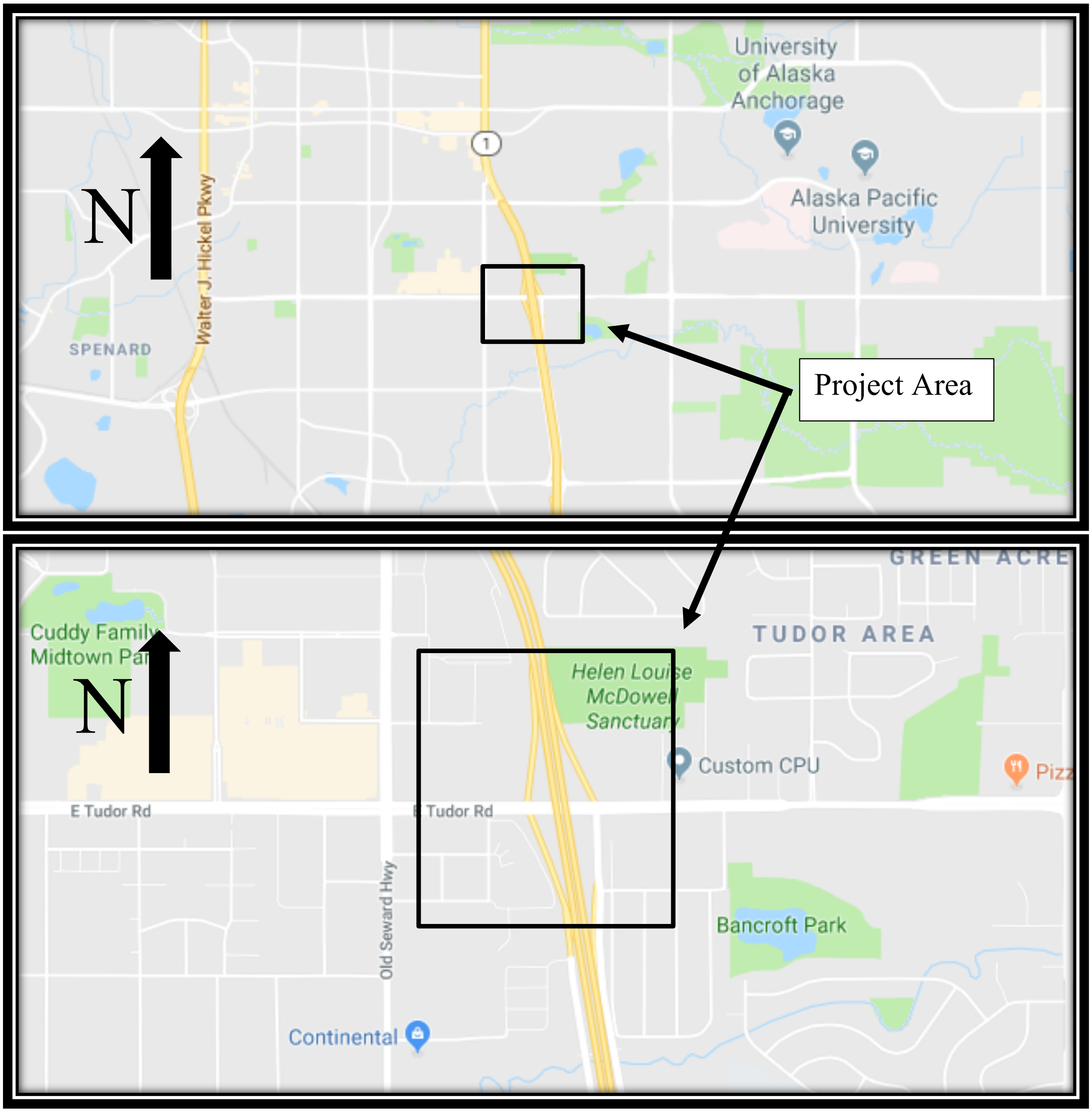

Figure 1 Location and Vicinity Map

1.0 PROJECT DESCRIPTION

1.1 Project Location and Description

The Alaska Department of Transportation and Public Facilities (DOT&PF), in cooperation with HIT Engineers, Inc. (HIT), proposes to improve the current level of service (LOS) of the New Seward Highway and Tudor Road Interchange by redesigning the existing interchange. The project is located between Section 29 and Section 32, Township 13N, Range 3W, Seward Meridian, Latitude 61.1809°N, Longitude 149.8606°W, USGS 1927 North American datum within the Municipality of Anchorage (MOA). See Figure 1 for the Location & Vicinity.

The proposed project will reconstruct the existing diamond interchange on the New Seward Highway and Tudor Road Interchange. Improvements to the project will include:

- Implementing dual-left turn movement for vehicles heading westbound from Tudor Road to southbound on the Seward Highway;
- Shortening the span of the bridge to decrease capacity on the interchange,
- Incorporating a raised median on the interchange to allow better channelization and driver comfortability.

1.2 Existing Facilities and Land Use

The interchange has a variety of facilities that surround it, especially residential zones. To the immediate Northeast of the interchange is the Alaska Career College and beyond that is a residential area. To the Southeast is the Tudor Bingo Center and the Alaska Lighting & Supply. Located to the Southwest are a few apartment buildings. And finally, to the Northwest is the US Fish & Wildlife Department Services.

1.3 Purpose and Need

The purpose of the project is to improve the current level of service by accommodating the through movement volumes for the westbound and eastbound directions of Tudor Road. Due to the limited capacity that the interchange can retain, congestion occurs during peak hours causing delays. In addition, based on the *Traffic Camera Count and Placement Information*, the westbound left-turn movement volume on the interchange will also need to be improved to accommodate vehicles heading southbound on the Seward Highway. Improvements to meet project needs include, but not limited to, implementing additional lanes, configuring traffic signals at or near the project area, and upgrading the interchange to meet current design standards.

2.0 DESIGN STANDARDS AND GUIDELINES

Design standards and guidelines that apply to the New Seward and Tudor Road Interchange are contained in the following publications:

Standards:

- A Policy on Geometric Design of Highways and Streets (PGDHS), 6th Edition, American Association of State Highway and Transportation Officials (AASHTO), 2011.
- Roadside Design Guide (RDG), 4th Edition, AASHTO, 2011.
- Alaska Highway Preconstruction Manual (HPCM), State of Alaska, DOT&PF, 2005 as amended.
- Alaska Highway Drainage Manual (AHDM), State of Alaska, DOT&PF, 2006.
- The Alaska Traffic Manual (ATM), consisting of the Manual on Uniform Traffic Control Devices (MUTCD), 2009 as amended, U.S. DOT, Federal Highway Administration (FHWA) and the Alaska Traffic Manual Supplement (ATMS), State of Alaska, DOT&PF, 2016.
- ADA Standards for Transportation Facilities, U.S. DOT, 2006.
- ADA Standards for Accessible Design, United States Department of Justice, 2010.
- Guide for the Development of Bicycle Facilities, 4th Edition, AASHTO, 2012.
- Recommended Practice for Roadway Lighting (RP-8-14), American National Standards Institute / Illuminating Engineering Society, 2014.
- Highway Capacity Manual (HCM), 5th Edition, Transportation Research Board, 2010.
- Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400), AASHTO, 2001.
- Design Criteria Manual (DCM), Municipality of Anchorage, Project Management & Engineering Department, 2007.

Guidelines:

- Proposed Accessibility Standards for Pedestrian Facilities in the Public Right-of-Way (PROWAG), United States Access Board, 2011.
- Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition, AASHTO, 2004.

Appendix A contains the project Design Criteria and Design Designation.

3.0 DISCUSSION OF ALTERNATIVES

The following four alternatives were analyzed to determine which would satisfy the most needs as part of the Preliminary Engineering Report.

3.1 No-Build Alternative

The first alternative is the No-Build alternative. Under this alternative, the existing roadway and interchange would remain unchanged. As a result, the New Seward Highway and Tudor Road Interchange would continue to have two through lanes on opposite directions (i.e. - westbound and eastbound) with each retaining a left-turn lane movement for the Seward Highway. No additional lanes, configuration to the traffic signals, or new interchange design would be administered to the interchange. This alternative would be the least expensive option as it would not need construction or right-of-way acquisition. However, this alternative would not increase the level of service nor meet the project purpose and needs.

3.2 Roundabout Interchange Alternative

The second alternative is to redesign the roadway as a Roundabout interchange. This alternative would require the west and east intersections of the interchange to be redesigned as roundabouts, similar to the layout located at the Dowling Road and Seward Highway interchange.

Although a roundabout interchange design would decrease the number of conflict points for both intersections, the capacity of which the interchange can accommodate will not be able to meet the demand. Consequently, this would result with a platoon of vehicles queuing up at each intersection increasing delays. Furthermore, the design of a roundabout will require significant right-of-way acquisition and utility relocations for both north and south of the interchange.

3.3 Diverging Diamond Interchange Alternative

The third alternative is to redesign the roadway as a Diverging Diamond interchange. The design would be similar to that of the interchange located in Muldoon near the Tikahtnu Commons Shopping Mall.

Given to its design, the Diverging Diamond has a higher design capacity that would accommodate the high demand capacity during peak hours. The design would require less right-of-way. However, a Diverging Diamond interchange would not include through movement along the frontage roads. This would cause massive delays for drivers travelling North on Brayton Drive.

3.4 Tight Diamond Interchange Alternative

The fourth alternative is to improve the existing Tight Diamond interchange. This is the preferred alternative.

In this alternative, the main reconstruction of the interchange would be decreasing the current length between the two intersections of 400 feet to 250 feet. This will allow for less vehicles to be stored within the interchange and allow those vehicles to be flush through the interchange more efficiently. The interchange will also include dual left turn lanes for the southbound on-ramp which will significantly decrease the time drivers will be waiting at the light. And to capitalize on the dual left turn lanes, the signal phasing will be better coordinated throughout the corridor. This will allow the interchange to be the most efficient it can be.

4.0 PREFERRED ALTERNATIVE

The preferred alternative is to design a Tight Diamond Interchange (TDI). The current design of the interchange is a Compressed Diamond interchange which is similar to the TDI, but the terminals are more than 400 feet from each other. The Tight Diamond interchange consists of the two terminals connected by a new bridge ranging from 250 feet to 400 feet. With the terminals being closer together, the traffic lights can run on the same cycle and increase the LOS by more efficiently sending drivers through the interchange. There will be a median on the bridge that will allow a dual turning lane for drivers travelling toward southbound on the New Seward Highway.

5.0 HORIZONTAL AND VERTICAL ALIGNMENT

5.1 Horizontal Alignment

The horizontal alignment for the Seward Highway mainline was obtained from the Tudor Road to Dowling Road, Seward Highway Reconstruction project and has not been modified for this project due to the recent construction of the mainline. However, because the existing Tudor Road alignment did not match the proposed geometry of Tudor Road, the alignment was modified with a design speed of 50-mph. The alignment for ramps T1 through T4 were designed with a 70 mph on-ramp design speed as well as a 50-mph off-ramp design speed. These were designed in accordance with the AASHTO geometric design of streets and highways. These alignments were created for the project because the east and west intersections moved closer with the Tight Diamond Interchange design in addition to the bridge widening.

5.2 Vertical Alignment

The vertical alignment for the Seward Highway mainline was obtained from the Tudor Road to Dowling Road, Seward Highway Reconstruction project and has not been modified for this project due to the recent construction of the mainline. However, the existing Tudor Road alignment did not match the proposed geometry of Tudor Road. Therefore, the sag curves and crest curves were redesigned with a k-value of 96 and 84, respectively. The sag curves and crest curves were present and handled with the AASHTO Geometric Design of Streets and Highways. These alignments were created for the project because the east and west intersections moved closer with the Tight Diamond Interchange design in addition to the bridge widening

6.0 ACCESS CONTROL FEATURES

Access control for the project will be assessed by the construction manager or contractor when design plans, and specifications are near completion and will not be assessed per the 10% to 15% scope of this project.

7.0 TRAFFIC ANALYSIS

Traffic analysis was performed on the current interchange conditions and on the preferred alternative. Level of Service (LOS), was calculated for the overall interchange, Tudor's through eastward movement, Tudor's through westward movement, Tudor's left turning lane onto the northbound ramp, and Tudor's left turning lane onto the southbound ramp. Delays at Tudor's intersections for through and left turning movement were additionally analyzed. The LOS for the existing conditions were computed as E, C, C, C, and E in respects to the overall interchange, Tudor's through eastward movement, Tudor's through westward movement, Tudor's left turning lane onto the northbound ramp, and Tudor's left turning lane onto the southbound ramp. This indicates that road sections that resulted in LOS E will require additional features to improve it to LOS C. To improve the interchange, dual turning lanes were added to Tudor's left turning lane onto the southbound ramp. This feature reduced the intersection delay for that movement from 21.394 seconds to 16.655 seconds. The intersections were also brought closer together to a distance of 250 feet. This will result in the optimization of the signals and for the two intersections to be controlled as a single intersection. As stated in the proposal of the preferred alternative (4.0 Preferred Alternative), this shortened distance will allow vehicles to pass through the storage section of the roadway between the two intersections unhindered. The inclusion of these features increased the LOS of the overall interchange and all the movements to a LOS C.

8.0 SAFETY IMPROVEMENTS

The various safety improvements made to this include ADA compliant curb ramps and parallel on/off ramps to reduce weaving. With the addition of coordinated signal phasing throughout the corridor, pedestrians will also have a more efficient walk across the bridge.

9.0 RIGHT-OF-WAY REQUIREMENTS

No additional right of way will be required for this project.

10.0 PEDESTRIAN AND BICYCLE FACILITIES

Pedestrian and bicycle accommodations for the New Seward Highway and Tudor Road interchange include a five-foot-wide sidewalk running across the Seward Highway over-pass on both sides. The sidewalk will comply with all ADA specifications. There will be no pedestrian traffic allowed onto the highway ramps.

11.0 UTILITY RELOCATION AND COORDINATION

Utility companies with facilities in the project limits include Alaska Communications, Inc. (ACS), Anchorage Waste and Water Utility (AWWU), General Communications Inc. (GCI), Chugach Electric Association (CEA), and ENSTAR Natural Gas (ENSTAR). In addition, utilities owned by the Municipality of Anchorage (MOA) are also present within the project limits.

Further coordination in the future, in the form of agreements, with the aforementioned utility companies will be required to relocate any conflicting facilities that are within the project boundaries.

12.0 COST ESTIMATE

The project cost estimate is as follows:

Preliminary Engineering	$	100,000
Right-of-Way	$	0
Utility Relocation	$	500,000
Construction	$	4,000,000
Contingency (15% of Construction)	$	600,000
Total	$	5,200,000

13.0 ENVIRONMENTAL COMMITMENTS AND CONSIDERATIONS

Updating the current New Seward Highway and Tudor Road interchange to shorten the length of the bridge that connects the intersections will not involve any significant environmental impacts. In an on-site visit was conducted on February 1st, 2019 it was observed that noise barriers were already constructed leading toward the northbound intersection along Brayton Drive. A completed environmental assessment will be provided in a later stage of the project to give a more detailed evaluation of the interchange.

14.0 BRIDGES

While this project incorporates a bridge (which runs east-west and spans 250 feet over New Seward), the design of said bridge will not be addressed at this stage of the project. When the bridge is eventually designed, local specifications and the AASHTO LFRD will be taken into consideration.

15.0 EXCEPTIONS TO DESIGN STANDARDS

There are no exceptions to design standards for this project.

APPENDIX A

Approved Design Criteria

PROJECT DESIGN CRITERIA

Project Name: Tudor Road and New Seward Highway Interchange Reconstruction

State Project No.: Federal Project No.: _____

Functional Classification: Interstate Terrain: Level

Segment (Tudor Road, New Seward Highway Overpass)

Present ADT (2017): 37,536 Mid-Design ADT (2027): _____ Design ADT (2037): _____

DHV (%): _____ Trucks (%): _____ Directional Split (%/%): _____

Pavement Design Year: _____ Pavement Design ESAL: _____

Design Turning Vehicle: _____

Project Type: New Construction/Reconstruction NHS: ☐ Non-NHS: ☐

FHWA 10 CONTROLLING DESIGN CRITERIA		SOURCE	STANDARD	AS PROPOSED	EXCEPTION[1]
Design Speed[1]		GB Table 10-1, p 10-89	70 mph	70 mph	Choose an item.
Lane Width	Travel	GB Table 3-29, p 3-103	12 ft	12 ft	Choose an item.
	Auxiliary	N/A	N/A	N/A	Choose an item.
Shoulder Width	Outside	GB 10.9.6, p 10-102	8-10 ft	8 ft	Choose an item.
	Inside	GB 10.9.6, p 10-102	2-4 ft	2-4 ft	Choose an item.
	Auxiliary	N/A	N/A	N/A	Choose an item.
Horizontal Curve Radius, min		GB Table 3-7, p 3-32	2040 ft	2040 ft	Choose an item.
Superelevation Rate, e, max		GB 3.3.3, p 3-30	6-8%	6%	Choose an item.
Stopping Sight Distance (SDD), min		GB Table 3-1, p 3-4	730 ft	730 ft	Choose an item.
Grade	Min.[2]	GB 3.4.2, p 3-119	0.3-0.5%	0.5%	Choose an item.
	Max.	GB 10.9.6, p 10-93	3-5%	4%	Choose an item.
Cross Slope		GB 10.9.6, p 10-93	2%	2%	Choose an item.
Vertical Clearance, _____________		N/A	N/A	N/A	Choose an item.
Design Loading Structural Capacity[1]		N/A	N/A	N/A	Choose an item.

[1] On low speed roadways (<50 mph) on the NHS, only Design Speed and Design Loading Structural Capacity require a Design Exception; all other criteria require a Design Waiver. For projects off the NHS, all criteria require a Design Waiver.

[2] Minimum grade is not one of the FHWA 10 Controlling Design Criteria and will require a Design Waiver for any variance.

<table>
<tr><th colspan="2">OTHER
DESIGN CRITERIA</th><th>SOURCE</th><th>STANDARD</th><th>AS DESIGNED</th><th>WAIVER</th></tr>
<tr><td colspan="2">Superelevation Transition, Δ</td><td>HPCM 1130.1.2, p 1130-1; GB Table 3-15, p 3-61</td><td>0.4%</td><td>0.4%</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Bridge Clear-Roadway Width</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td rowspan="2">Vertical Curvature (min)</td><td>K (crest)</td><td>GB Table 3-34, p 3-155</td><td>247</td><td>247</td><td>Choose an item.</td></tr>
<tr><td>K (sag)</td><td>GB Table 3-34, p 3-161</td><td>181</td><td>181</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Lateral Offset to Obstruction</td><td>RDG 3.4.1, p 3-13</td><td>1.5 ft</td><td>1.5 ft</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Surfacing Material</td><td>HPCM 1180.3.1</td><td>HMA</td><td>HMA</td><td>Choose an item.</td></tr>
<tr><td rowspan="4">Clear Zone</td><td>Slope (fill)</td><td rowspan="4">GB 4.6.1, p 4 -15, RDG Table 3-1, p 3-2</td><td>3:1 or flatter</td><td>3:1 or flatter</td><td>Choose an item.</td></tr>
<tr><td>Width (fill)</td><td>14-28 ft</td><td>14-28 ft</td><td>Choose an item.</td></tr>
<tr><td>Slope (cut)</td><td>3:1 or flatter</td><td>3:1 or flatter</td><td>Choose an item.</td></tr>
<tr><td>Width (cut)</td><td>14-28 ft</td><td>14-28 ft</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Bicycle Lane Width</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Sidewalk/Pathway Width</td><td>GB 5.3.2, p 5-15</td><td>4-8 ft</td><td>4-8 ft</td><td>Choose an item.</td></tr>
<tr><td rowspan="3">Intersection Sight Distance*, Choose an item.</td><td>Left Turn (GB Case B1)</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td>Right Turn (GB Case B2)</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td>Crossing (GB Case B3)</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Passing Sight Distance</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Degree of Access Control</td><td>GB 2.5.2, p 2-72</td><td colspan="2">Full</td><td>Choose an item.</td></tr>
<tr><td rowspan="2">Median</td><td>Treatment</td><td rowspan="2">N/A</td><td colspan="2">N/A</td><td>Choose an item.</td></tr>
<tr><td>Width</td><td>N/A</td><td>N/A</td><td>Choose an item.</td></tr>
<tr><td colspan="2">Illumination</td><td></td><td colspan="2"></td><td>Choose an item.</td></tr>
<tr><td colspan="2">Curb Type</td><td>GB 4.7.2, p 4-18</td><td colspan="2">Sloping</td><td>Choose an item.</td></tr>
</table>

* Attach calculations

Notes:

Proposed by:	______________________ Designer (Consultant or Staff)	Date:________________
Recommended by:	______________________ Engineering Manager	Date:________________
Accepted by:	______________________ Regional Preconstruction Engineer	Date:________________

Example Calculations for Intersection Sight Distance

Calculation Sheet for Cases B1, B2, and B3 (Intersection Sight Distance, Passenger Car)

EQUATIONS:

1.) $\boldsymbol{t_g = t_g + (n - 1) * (0.5), \text{ if } n > 2}$

t_g = time gap for minor road vehicle to enter the major road (s)

t_g = time gap at design speed of major road (s)

n = number of lanes to cross

2.) $\boldsymbol{ISD = 1.47 * V_{major} * t_g}$ *(from Green Book, pg. 9-37, Equation 9-1)*

ISD = Intersection Sight Distance (length of the leg of sight triangle along the major road) (ft)

V_{major} = design speed of the major road (mph)

CASE B1: Left Turn from the Minor Road *(Green Book, pg. 9-36)*

Given: n = 3 lanes, V_{major} = 45 mph, t_g = 7.5 s *(from Green Book, pg. 9-37, Table 9-5);*

t_g = 7.5 + (3 – 1) * (0.5) = 8.5 s

ISD = 1.47 * 45 * 8.5 = 562.275 ft = > **use 565 ft**

CASE B2: Right Turn from the Minor Road *(Green Book, pg. 9-40)*

Given: n = 0 lanes, V_{major} = 45 mph, t_g = 6.5 s *(from Green Book, pg. 9-40, Table 9-7);*

t_g = t_g = 6.5 = 6.5 s

ISD = 1.47 * 45 * 6.5 = 429.975 ft => **use 430 ft**

CASE B3: Crossing Maneuver from the Minor Road *(Green Book, pg. 9-43)*

Given: n = 5 lanes, V_{major} = 45 mph, t_g = 6.5 s *(from Green Book, pg. 9-40, Table 9-7);*

t_g = 6.5 + (5 – 1) * (0.5) = 8.5 s

ISD = 1.47 * 45 * 8.5 = 562.275 ft = > **use 565 ft**

PROJECT DESIGN CRITERIA

Project Name: Tudor Road and New Seward Highway Interchange Reconstruction

State Project No.: Federal Project No.: _____

Functional Classification: Principal Arterial Terrain: Level

Segment (Tudor Road, New Seward Highway Overpass)

Present ADT (2017): 37,536 Mid-Design ADT (2027): _____ Design ADT (2037): _____

DHV (%): _____ Trucks (%): _____ Directional Split (%/%): _____

Pavement Design Year: _____ Pavement Design ESAL: _____

Design Turning Vehicle: _____

Project Type: New Construction/Reconstruction NHS: ☐ Non-NHS: ☐

FHWA 10 CONTROLLING DESIGN CRITERIA		SOURCE	STANDARD	AS PROPOSED	EXCEPTION[1]
Design Speed[1]		GB 7.3.2, P 7-27	30-60 mph	50 mph	Choose an item.
Lane Width	Travel	GB 7.3.3, p 7-29	10-12 ft	12 ft	Choose an item.
	Auxiliary	GB 9.7.1, p 9-124	10-12 ft	10 ft	Choose an item.
Shoulder Width	Outside	GB 4.7.3, p 4-19, Table 7-3	0-4 ft	0-4 ft	Choose an item.
	Inside	N/A	N/A	N/A	Choose an item.
	Auxiliary	GB 9.7.1, p 9-124	0-4 ft	0-4 ft	Choose an item.
Horizontal Curve Radius, min		HPCM Figure 1120-1, p 1120-1	835 ft	835 ft	Choose an item.
Superelevation Rate, e, max		HPCM 1130.1.2; GB 3.3.3, p 3-30	6-8%	6-8%	Choose an item.
Stopping Sight Distance (SDD), min		HPCM Figure 1120-1, p 1120-1	425 ft	425 ft	Choose an item.
Grade	Min.[2]	HPCM Figure 1120-1, p 1120-3	1%	1%	Choose an item.
	Max.	HPCM Figure 1120-1, p 1120-3	4%	4%	Choose an item.
Cross Slope		HPCM Figure 1130-1, p 1130-13	2%	2%	Choose an item.
Vertical Clearance, _____________		HPCM Figure 1130-1, p 1130-13	>16.5 ft	17 ft	Choose an item.
Design Loading Structural Capacity[1]		GB 8.2.8, p 8-4	HL-93	HL-93	Choose an item.

[1] On low speed roadways (<50 mph) on the NHS, only Design Speed and Design Loading Structural Capacity require a Design Exception; all other criteria require a Design Waiver. For projects off the NHS, all criteria require a Design Waiver.

[2] Minimum grade is not one of the FHWA 10 Controlling Design Criteria and will require a Design Waiver for any variance.

OTHER DESIGN CRITERIA		SOURCE	STANDARD	AS DESIGNED	WAIVER
Superelevation Transition, Δ		HPCM 1130.1.2, p 1130-1; GB Table 3-15, p	0.5%	0.5%	Choose an item.
Bridge Clear-Roadway Width		GB 7.3.5, p 7-38	82-92 ft	82-92 ft	Choose an item.
Vertical Curvature (min)	K (crest)	GB Table 3-34, p 3-155	84	84	Choose an item.
	K (sag)	GB Table 3-34, p 3-155	96	96	Choose an item.
Lateral Offset to Obstruction		RDG 3.4.1, p 3-13	1.5 ft	1.5 ft	Choose an item.
Surfacing Material		HPCM 1180.3.1	HMA	HMA	Choose an item.
Clear Zone	Slope (fill)	GB 4.6.1, p 4 -15, RDG Table 3-1, p 3-2	3:1 or flatter	3:1 or flatter	Choose an item.
	Width (fill)		14-28 ft	14-28 ft	Choose an item.
	Slope (cut)		3:1 or flatter	3:1 or flatter	Choose an item.
	Width (cut)		14-28 ft	14-28 ft	Choose an item.
Bicycle Lane Width		N/A	N/A	N/A	Choose an item.
Sidewalk/Pathway Width		GB 5.3.2, p 5-15	4-8 ft	5 ft	Choose an item.
Intersection Sight Distance*, Choose an item.	Left Turn (GB Case B1)	N/A	N/A	N/A	Choose an item.
	Right Turn (GB Case B2)	GB 9.5.3, p 9-41	480 ft	480 ft	Choose an item.
	Crossing (GB Case B3)	N/A	N/A	N/A	Choose an item.
Passing Sight Distance		N/A	N/A	N/A	Choose an item.
Degree of Access Control		GB 2.5.2, p 2-72	Partial		Choose an item.
Median	Treatment	HPCM Table 1150-2, p 1150-2	Raised, Curbed		Choose an item.
	Width		4 ft min	4 ft min	Choose an item.
Illumination					Choose an item.
Curb Type		GB 4.7.2, p 4-18	Sloping		Choose an item.

* Attach calculations

Notes:

Proposed by:	______________________ Designer (Consultant or Staff)	Date:________________
Recommended by:	______________________ Engineering Manager	Date:________________
Accepted by:	______________________ Regional Preconstruction Engineer	Date:________________

Example Calculations for Intersection Sight Distance

Calculation Sheet for Cases B1, B2, and B3 (Intersection Sight Distance, Passenger Car)

EQUATIONS:

1.) $\boldsymbol{t_g = t_g + (n - 1) * (0.5), \text{ if } n > 2}$

t_g = time gap for minor road vehicle to enter the major road (s)

t_g = time gap at design speed of major road (s)

n = number of lanes to cross

2.) $\boldsymbol{ISD = 1.47 * V_{major} * t_g}$ *(from Green Book, pg. 9-37, Equation 9-1)*

ISD = Intersection Sight Distance (length of the leg of sight triangle along the major road) (ft)

V_{major} = design speed of the major road (mph)

CASE B1: Left Turn from the Minor Road *(Green Book, pg. 9-36)*

Given: n = 3 lanes, V_{major} = 45 mph, t_g = 7.5 s *(from Green Book, pg. 9-37, Table 9-5);*

t_g = 7.5 + (3 – 1) * (0.5) = 8.5 s

ISD = 1.47 * 45 * 8.5 = 562.275 ft = > **use 565 ft**

CASE B2: Right Turn from the Minor Road *(Green Book, pg. 9-40)*

Given: n = 0 lanes, V_{major} = 45 mph, t_g = 6.5 s *(from Green Book, pg. 9-40, Table 9-7);*

$t_g = t_g$ = 6.5 = 6.5 s

ISD = 1.47 * 45 * 6.5 = 429.975 ft => **use 430 ft**

CASE B3: Crossing Maneuver from the Minor Road *(Green Book, pg. 9-43)*

Given: n = 5 lanes, V_{major} = 45 mph, t_g = 6.5 s *(from Green Book, pg. 9-40, Table 9-7);*

t_g = 6.5 + (5 – 1) * (0.5) = 8.5 s

ISD = 1.47 * 45 * 8.5 = 562.275 ft = > **use 565 ft**

APPENDIX B - C will be addressed in a later phase of the design process.

APPENDIX D

Traffic Analysis

N = Lanes with through traffic in one direction

Lw = Lane width, feet

Rlc = Right side lateral clearance, feet

PHF = Peak Hour Factor

fLW = adjustment for lane with

fLC = adjustment for lateral clearance

fp = adjustment factor for driver population

x = volume-to-caoacity ratio (LOS A = 0.22, LOS B = 0.35, LOS C = 0.55, LOS D = 0.55, LOS E & F = 0.92)

tm = move-up time (2 sec)

Peakhr = Peak hour volume, vehicles per hour

TRD = total ramp density, ramps/mi

FFS = free-flow speed of the freway, mi/h

BFFS = base free-flow speed (posted speedlimit + 7) (turning lanes is half of posted speedlimit), mi/h

fHV = adjustment factor for heavy vehicles

d = delay in all-way stop control intersection, sec

hd = departure headway (1 lane = 5.5, 2 lane = 6.5), sec

Seward Hwy & Tudor Interchange: Level of Service

$N := 3$

$TRD := 4$

$L_w := 12$

$Peak_{hr} := 3657$

$R_{lc} := 4$

$f_{HV} := 1 - 1.5\% \cdot 1 = 0.985$

$PHF := \frac{0.96 + 0.96}{2} = 0.96$

$f_p := 1$

$BFFS := 45 + 7 = 52$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9$ $\quad f_{LC} := 0.8$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 38.982$

$$v_p := \frac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 1.289 \cdot 10^3$$

Seward Hwy & Tudor Interchange: Level of Service = LOS E

Tudor Through Eastward Movement: Level of Service

$N := 2$ $TRD := 4$

$L_w := 12$ $Peak_{hr} := 1695$

$R_{lc} := 4$ $f_{HV} := 1 - 1.2\% \cdot 1 = 0.988$

$PHF := 0.96$ $f_p := 1$

$BFFS := 45 + 7 = 52$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9$ $f_{LC} := 1.2$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 38.582$

$$v_p := \frac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 893.535$$

Tudor Through Eastward Movement: Level of Service = LOS C

$h_d := 6.5$ $x := 0.55$ $t_m := 2.5$

d = hd - tm + 225*(x -1+((x-1)^2 + (hd*x/112.5))^0.5 + 5

$$d := h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d \cdot x}{112.5}}\right) + 5 = 16.655$$

Tudor Through Eastward Movement: Delay = 16.655 sec

Tudor Through Westward Movement: Level of Service

$N := 2$ $TRD := 4$

$L_w := 12$ $Peak_{hr} := 1470$

$R_{lc} := 4$ $f_{HV} := 1 - 2.7\% \cdot 1 = 0.973$

$PHF := 0.96$ $f_p := 1$

$BFFS := 45 + 7 = 52$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9$ $f_{LC} := 1.2$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 38.582$

$$v_p := \frac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 786.871$$

Tudor Through Westward Movement: Level of Service = LOS C

$h_d := 6.5$ $x := 0.55$ $t_m := 2.5$

d = hd - tm + 225*(x -1+((x-1)^2 + (hd*x/112.5))^0.5 + 5

$$d := h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d \cdot x}{112.5}} \right) + 5 = 16.655$$

Left Turn Onto Seward Hwy NB On-Ramp: Delay = 16.655 sec

Left Turn Onto Seward Hwy NB On-Ramp: Level of Service

$N := 1$ $TRD := 4$

$L_w := 12$ $Peak_{hr} := 211$

$R_{lc} := 0$ $f_{HV} := 1 - 1.2\% \cdot 1 = 0.988$

$PHF := 0.96$ $f_p := 1$

$BFFS := 45 \cdot .5 = 22.5$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9 \qquad f_{LC} := 0$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 10.282$

$v_p := \dfrac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 222.461$

Left Turn Onto Seward Hwy NB On-Ramp: Level of Service = LOS C

$h_d := 5.5 \qquad x := 0.55 \qquad t_m := 2.5$

d = hd - tm + 225*(x -1+((x-1)^2 + (hd*x/112.5))^0.5 + 5

$$d := h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d \cdot x}{112.5}} \right) + 5 = 14.513$$

Left Turn Onto Seward Hwy NB On-Ramp: Delay = 14.513 sec

<u>Left Turn Onto Seward Hwy SB On-Ramp: Level of Service</u>

$N := 1 \qquad TRD := 4$

$L_w := 12 \qquad Peak_{hr} := 378$

$R_{lc} := 0 \qquad f_{HV} := 1 - 2.7\% \cdot 1 = 0.973$

$PHF := 0.96 \qquad f_p := 1$

$BFFS := 45 \cdot .5 = 22.5$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9 \qquad f_{LC} := 0$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 10.282$

$v_p := \dfrac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 404.676$

Left Turn Onto Seward Hwy SB On-Ramp: Level of Service = LOS E

$h_d := 5.5 \qquad x := 0.92 \qquad t_m := 2.5$

d = hd - tm + 225*(x -1+((x-1)^2 + (hd*x/112.5))^0.5 + 5

$$d := h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d \cdot x}{112.5}} \right) + 5 = 41$$

Left Turn Onto Seward Hwy SB On-Ramp: Delay = 41 sec

Alternative (Tight Diamond) Seward Hwy & Tudor Interchange: Level of Service

$N := 4$ $\quad$ $TRD := 4$

$L_w := 12$ $\quad$ $Peak_{hr} := 3657$

$R_{lc} := 5$ $\quad$ $f_{HV} := 1 - 1.5\% \cdot 1 = 0.985$

$PHF := \frac{0.96 + 0.96}{2} = 0.96$ $\quad$ $f_p := 1$

$BFFS := 45 + 7 = 52$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9$ $\quad$ $f_{LC} := 0.2$

$$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 39.582$$

$$v_p := \frac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 966.846$$

Alternative (Tight Diamond) Seward Hwy & Tudor Interchange: Level of Service = LOS C

Althernative (Tight Diamond) Tudor Through Eastward Movement: Level of Service and Delay

No additional changes were implemented: LOS and delay stays the same at C and at 16.655 secs

Althernative (Tight Diamond) Tudor Through Westward Movement: Level of Service and Delay

No additional changes were implemented: LOS and delay stays the same at C and at 16.655 secs

Althernative (Tight Diamond) Left Turn Onto Seward Hwy NB On-Ramp: Level of Service and Delay

No additional changes were implemented: LOS and delay stays the same at C and at 14.513 secs

Alternative (Tight Diamond) Left Turn Onto Seward Hwy SB On-Ramp: Level of Service

$N := 2$ $TRD := 4$

$L_w := 12$ $Peak_{hr} := 378$

$R_{lc} := 5$ $f_{HV} := 1 - 2.7\% \cdot 1 = 0.973$

$PHF := 0.96$ $f_p := 1$

$BFFS := 45 \cdot .5 = 22.5$

FFS = BFFS - fLW - fLC - 3.22*(TRD)^0.84

$f_{LW} := 1.9$ $f_{LC} := 0.6$

$FFS := BFFS - f_{LW} - f_{LC} - 3.22 \cdot TRD^{0.84} = 9.682$

$$v_p := \frac{Peak_{hr}}{PHF \cdot N \cdot f_{HV} \cdot f_p} = 202.338$$

Alternative (Tight Diamond) Left Turn Onto Seward Hwy SB On-Ramp: Level of Service = LOS C

$h_d := 6.5$ $x := 0.55$ $t_m := 2.5$

d = hd - tm + 225*(x -1+((x-1)^2 + (hd*x/112.5))^0.5 + 5

$$d := h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d \cdot x}{112.5}} \right) + 5 = 16.655$$

Alternative (Tight Diamond) Left Turn Onto Seward Hwy SB On-Ramp: Delay = 16.655 sec

Traffic Analysis Data Summary

	Existing Conditions		Preferred Alternative	
	LOS	Intersection Delay, sec	LOS	Intersection Delay, sec
Interchange	E	N/A	C	N/A
Tudor Eastward	C	16.655	C	16.655
Tudor Westward	C	16.655	C	16.655
Left Turn On NB Ramp	C	14.513	C	14.513
Left Turn On SB Ramp	E	41	C	16.655

The information in this report is compiled for highway safety planning purposes. Federal law prohibits its discovery or admissibility in litigation against state, tribal or local government that involves a location or locations mentioned in the collision data. 23 U.S.C. § 409; 23 U.S.C. § 148(g); *Walden v. DOT*, 27 P.3d 297, 304-305 (Alaska 2001).

APPENDICES E - K will be addressed in a later phase of the design process.

At this time, no significant design changes were made after the approval of this document. The final as-built plans for this project will be available in Central Files within the Highway Design Section (4111 Aviation Avenue, Anchorage, AK 99502).